

# ORDINARY DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS

**23MA1102**

**Credits:3**

Instruction : 3 periods & 1 Tutorial/Week

Sessional Marks:40

End Exam : 3 Hours

End Exam Marks:60

**Prerequisites:** Matrices, Differentiation, Differential equations, Integration and Functions.

**Course Objectives:**

Create and analyze mathematical models using first and higher order differential equations to solve application problems such as electrical circuits, orthogonal trajectories and Newton’s law of cooling and also familiarize the student in various topics in numerical analysis such as interpolation, numerical differentiation, integration and direct methods for solving linear system of equations.

**Course Outcomes:** By the end of the course, students will be able to

1.	Demonstrate solutions to first order differential equations by various methods and solve basic application problems related to electrical circuits, orthogonal trajectories and Newton’s law of cooling.
2.	Discriminate among the structure and procedure of solving a higher order differential equations with constant coefficients and variable coefficients.
3.	Apply various numerical methods to solve linear and non-linear equations.
4.	Familiarize with numerical integration and differentiation.
5.	Understand Laplace transforms and its properties, and finding the solution of ordinary differential equations.

**CO-PO –PSO Mapping:**

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1	1							1	2			
CO2	3	2	1	1							1	2			
CO3	3	2	1	1							1	2			
CO4	3	2	1	1							1	2			
CO5	3	2	1	1							1	2			

Correlation levels      1: Slight (Low)   2: Moderate (Medium)   3: Substantial (High)

## Mapping of Course Outcomes with Program Outcomes & Program Specific Outcomes:

CO-PO-PSO Justification	
1	CO1 is widely used to solve complex engineering problems in all the areas like Fluid dynamics, Mass transfer, Signals and Systems, and Dynamics.
2	CO2 is widely used to solve complex engineering problems in all the areas like Fluid dynamics, Mass transfer, Signals and Systems, and Dynamics.
3	CO3 deals with the techniques that are used to find an approximate real root of the given algebraic and transcendental equations.
4	CO4 deals with the knowledge of interpolation, numerical differentiation and integration, which is used all the areas of engineering sciences.
5	CO5 deals with the knowledge of Laplace transforms which are widely used in all the areas of engineering sciences.

## SYLLABUS

### UNIT I

**10 Periods**

**Ordinary differential equations of first order and its applications :** Linear equations - Bernoulli's equations - Exact differential equations - Equations reducible to exact equations - Orthogonal trajectories - Simple electric circuits (L –R circuit problems) - Newton's law of cooling.

**Sections: 11.9, 11.10, 11.11, 11.12, 12.3, 12.5 and 12.6.**

### UNIT II

**10 Periods**

**Higher order linear differential equations and its applications :** Definitions - Operator D - Rules for finding the complementary function - Rules for finding the particular integral - Method of variation of parameters - Equations reducible to linear equations with constant coefficients: Cauchy's homogeneous linear equation - Legendre's linear equation. Applications: L – C – R circuit problems.

**Sections: 13.1, 13.3, 13.4, 13.6, 13.8(I), 13.9, 14.5(ii).**

### UNIT III

**10 Periods**

**Numerical solutions of algebraic and transcendental equations :**

**Solution of algebraic and transcendental equations:** Bisection method - Regula-Falsi method - Newton-Raphson method.

**Solution of linear simultaneous equations:** Gauss elimination - Gauss Jordan - Gauss Seidel.

**Sections: 28.2, 28.3, 28.5, 28.6(1,2), 28.7(2)**

#### UNIT IV

10 Periods

**Interpolation, Numerical Differentiation and Integration** : Finite differences - Other difference operators - Relation between operators - To find one or more missing terms - Newton's interpolation formulae. Interpolation with unequal intervals: Lagrange's interpolation formula.

**Numerical differentiation:** Newton's forward and backward differences formula to compute first and second derivatives.

**Numerical integration:** Trapezoidal rule - Simpson's  $1/3^{\text{rd}}$  and  $3/8^{\text{th}}$  rules.

**Sections:** 29.1(1,2), 29.4(i), 29.5, 29.6(1,2), 29.9, 29.10, 30.2(1,2), 30.6, 30.7, 30.8.

#### UNIT V

10 Periods

**Laplace Transforms and its applications** : Introduction - Definitions - Transforms of elementary functions - properties of Laplace transforms - Transforms of periodic functions - Transforms of derivatives - Transforms of integrals - Multiplication by  $t^n$  - Division by  $t$  - (All properties without proofs) - Evaluation of integrals by Laplace transforms.

Inverse transforms – method of partial fractions - Other methods of finding inverse transforms - Convolution theorem (without proof) - Application's to differential equations - Unit step function and unit impulsive functions.

**Sections:** 21.1, 21.2, 21.3, 21.4, 21.5, 21.7, 21.8, 21.9, 21.10, 21.11, 21.12, 21.13, 21.14, 21.15, 21.17 and 21.18.

#### TEXT BOOKS:

1. **B. S. Grewal**, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.

#### REFERENCE BOOKS:

1. **Erwin Kreyszig**, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.
2. **N. P. Bali**, Engineering Mathematics, Lakshmi Publications.
3. **George B. Thomas, Maurice D. Weir and Joel Hass**, Thomas, Calculus, 13/e, Pearson Publishers, 2013.
4. **H. K. Dass**, Advanced Engineering Mathematics, S. Chand and company Pvt. Ltd.
5. **Michael Greenberg**, Advanced Engineering Mathematics, Pearson, Second Edition.